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Norton Sound Winter Red King Crab Studies, 2004

by

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and

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Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



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ABSTRACT

Biological data were collected for a winter red king crab *Paralithodes camtschaticus* pot survey project, begun in February of 1982 by the Alaska Department of Fish and Game to monitor the nearshore distribution, abundance, and life history parameters of the red king crab population in the Nome area. Monitoring was done by catching with pots, measuring, and tagging red king crabs through established area stations in the sea ice offshore of Nome. Staff also monitored the winter subsistence and commercial fisheries to evaluate crab abundance available to local users. Project data were incorporated into a length based population model that had been developed to predict population estimates for the red king crab biomass in Norton Sound. A total of 286 male and 9 female red king crabs were captured and sampled at 8 sampling sites between February 23 and April 9, 2004. A total of 77 pot lifts were made for an overall catch per unit effort (CPUE) of 3.7 male and 0.1 female red king crabs. Carapace length measurements and shell age were recorded from all male king crabs caught. Of the male king crabs, 49.6% were prerecruit, 37.1% were recruit, and 13.3% postrecruit. Analysis of the 2004 winter data indicated recruitment almost doubled from 2003 and a trend of increased legal crab abundance was evidenced for the near future.

Key words: Norton Sound, red king crab, distribution, abundance, tagging, sea ice, subsistence, crab pots.

INTRODUCTION

Red king crabs, *Paralithodes camtschaticus*, support both commercial and subsistence harvests in the Norton Sound area. For both fisheries, effort is concentrated in the vicinity of Nome. Commercial fisheries occur during the winter and summer months, with most of the catch occurring in the summer. Subsistence fisheries occur primarily in winter months and sporadically in summer months. The king crab population is concentrated near the shore from December through April, during which time shorefast ice allows subsistence fishers easy access. A winter red king crab pot survey project began in February of 1982; sampling procedures were standardized in 1983; and subsequent results were reported [Schwarz and Lean (1982, 1983, 1984), Lean and Brannian (1987), Lean (1987), Bue and Lean (1990), Knuepfer and Gebhard (1990), Brennan and Anderson (1993), Brennan (1993, 1998, 1999, 2000), Brennan and Karpovich (2002 and 2003), Brennan and LaFlamme (1995), Rob (1996), and Rob and Fair (1997)].

Shorefast and sea ice conditions constantly change during the winter months and from year to year, affecting the placement of fishing stations. For easier access, sampling sites from 1982 until 1987 were confined to a single transect of shorefast ice extending 0.5 to 2 miles directly offshore from the Nome Post Office. Poor ice conditions precluded any surveys in 1988. During the 1989 and 1990 seasons, the study area was expanded 6 miles to the east and west of Nome where subsistence activity occurs. Survey effort was reduced in 1991 and 1993 because of poor ice conditions and budget constraints. In 1992 and 1994, the project was not funded. The study site was expanded in 1996 to the vicinity of Bluff, 50 miles east of Nome. The following year the active ice edge was closer to shore, and sea ice conditions were quite rough because of pressure ridges. Pots were established in more shallow water than in the past, and unstable ice prevented fishing with pots in the vicinity of Bluff. From 1998 to 2000, traditional ice stations closer to Nome were fished. In 2001 sea ice around Nome was extremely unstable. Pots deployed in traditional areas were lost when shore ice broke off at the beginning of the project. Three pots were deployed from the ice that remained close to shore but few crabs were captured in these pots. In 2002 and 2003, traditional ice stations were fished once again and ice was stable throughout most of the winter.

The purpose of this study is to collect biological data during the winter months for monitoring the near shore distribution, abundance, and life history of the red king crab population. This collection is done by catching, measuring, and tagging red king crabs through established area stations in the sea ice offshore of Nome. The winter subsistence and commercial fisheries are monitored to evaluate the abundance available to local users. Winter project data are incorporated into a length based population model (Zheng et al. 1998) that was developed to predict population estimates for the red king crab biomass in Norton Sound. This model improves management of the red king crab fisheries by providing an annual estimate used to determine the guideline harvest level for the summer commercial king crab fishery. Before development of the length based model, the triennial Norton Sound king crab survey was the only means of determining the crab biomass.

OBJECTIVES

Objectives for the 2004 winter field season:

1. Measure and record the shell age, size, and number of sublegal and legal male red king crabs caught in order to evaluate recruitment into legal population before the summer fishery.
2. Tag all male new-shell red king crabs with carapace length ≤ 100 mm, as part of ongoing studies to estimate growth and movement of tagged crabs recaptured in summer and winter fisheries.
3. Monitor the abundance of king crab catch accessible to winter subsistence and commercial users in the Nome area.
4. Monitor the intensity and distribution of winter fishing effort in the Nome area.
5. Measure and record the size and number of female red king crabs captured and their egg clutch size.
6. Describe relative distribution of crabs within the winter 2004 study area using catch per unit effort (CPUE) information.
7. Record other biological data such as incidence of disease, parasitism, and other species captured.

METHODS

Four survey stations comprised of two sampling sites each were established in an area spanning from approximately 12 miles west of Nome to 5 miles east of Nome (Table 1) beginning February 19, 2004. Historically, stations were located 5 miles east of Nome, directly in front of Nome, and 3 and 7 miles west of Nome. However, due to unstable ice and pressure ridges in places, only half the stations were near historical locations. Each sampling site was located in water ranging from 26 feet to 46 feet deep and from approximately 0.5 mile to 0.75 mile offshore, in contrast to previous years when pots were deployed in waters up to 2 miles offshore. Travel to and from stations was by snowmachines towing a sled to carry supplies and equipment.

By using onshore landmarks, historical station areas were located, and the sampling sites recorded with a handheld Global Positioning System (GPS) receiver (Garmin GPS 76¹). A chainsaw was used to cut through the ice to determine its thickness. When ice was found between 1 and 3 feet thick, a square hole about 5 feet long on each side was cut in the ice using the chainsaw. Water depth was checked using a weighted string. Other tools used included ice chisels or “tuks”, shovels, and long poles. Conical, 4 foot diameter “Japanese style” king crab pots were baited with 2 one-quart bait containers filled with semi-frozen herring chopped into inch-long pieces. Saffron cod was unavailable and therefore not used as additional bait as in previous years. Each pot was deployed and attached to a line tethered to a stake at the ice surface. Each hole was covered with Styrofoam and plywood to reduce refreezing of the hole and the stake marked per regulation (5AAC 34.925).

Once pots were deployed, each pot was checked and rebaited once or twice per week, depending on weather. When pots were checked, they were brought to the surface and suspended to keep all crabs in the pot immersed in water. Crabs were removed one at a time, determined to be legal or sublegal, and measured biologically to the nearest millimeter. A legal red king crab is a male crab with a shell width ≥ 4.75 inches (121 mm), including spines (legal measurement). The biological measurement is the measurement taken from the posterior margin of the right eye orbit of the carapace to the center of the posterior carapace margin. Shell age was determined as new or old shell by observing features such as scarring on the ventral surface, dullness on the dactyl tips and attached barnacle sizes. Egg development and clutch size of female crabs were recorded. All male king crabs less than 101 mm in carapace length were tagged with hog rings with spaghetti tags to estimate growth rates. Any prior injuries on all crabs caught were recorded. All crabs were released into the same hole in which they were caught.

Conversation with commercial and subsistence fishers was solicited to get their impressions of the season, and how abundant the crab appeared. Required subsistence permits that must be returned were given out to fishers for recording their catches. Commercial fishers must report and turn in fish tickets to the Nome ADF&G office weekly. The commercial harvest was then tracked inseason.

RESULTS

A total of 286 male (of which 92 were tagged) and 9 female red king crabs were captured and sampled between February 23 and April 9, 2004. A total of 77 pot lifts were made for an overall catch per unit effort (CPUE, defined as the number of crabs per pot lift) of 3.7 male and 0.1 female red king crabs (Table 1). The Nome station had both the highest (sampling site Nome 3) and lowest (Nome 2) CPUE. Catch rates varied between 0 and 9.0 over the season with no observable pattern (Table 2). The number of male and female king crabs caught and the male CPUE were all well below that of the 2003 study and less than a third of the averages from the winter surveys 1983-2003 (Table 3).

Of the 286 male crabs caught, 49.6% were prerecruit (sublegal crab with carapace length (CL) ≤ 115 mm), 37.1% were recruit (legal new-shell crab with CL ≤ 115 mm), and 13.3% postrecruit (legal new-shell crab with CL > 115 mm and all legal old shell) (Table 4). This composition of

¹ Product names used in this report are included for scientific completeness, but do not constitute a product endorsement.

male red king crabs changed from the 2003 survey. The prerecruit catch proportion was lower than that of the previous two years, even though it was similar to the 18-year average (Table 3). Of the total male catch, there were no prerecruit threes ($CL \leq 76$ mm) captured in 2004 and prerecruit twos ($76 \text{ mm} \leq CL \leq 89$ mm) made up only 9.4%, less than half compared to 2003. The catch proportions of prerecruit threes and twos have been decreasing since 2002. Only the catch proportion of prerecruit ones (sublegal crabs with $CL > 89$ mm) was similar to the previous year.

The legal crab catch proportion of 50.4% is greater than that observed in 2003, and slightly above the average for 1983-2003 (Table 3). Recruit crab made up more than a third of all male crabs captured and almost doubled from the 2003 study, while the catch proportion of postrecruit crab was slightly less than the previous year. Legal crabs captured during the 2004 winter survey had an average length of 112 mm, similar to the average from 1991-2003.

Of the 9 female crabs caught, 5 were juveniles ($CL < 72$ mm, no eggs) and 4 adults. The average CL was 67 mm for juveniles, and 89 mm for adult females. One adult female had an egg clutch 90-100% full, two had egg clutches 60-89% full, and one had no egg clutch. All egg clutches had purple or dark brown eggs.

Similar to past studies, other species caught included Arctic Lyre crabs *Hyas coarctatus*, soft crabs *Hapalogaster grebnitzkii*, flatbottom sea stars *Asterias*, sea urchins of the genus *Strongylocentrotus*, shrimp *Pandalus* (sp.), saffron cod *Eleginus gracilis*, unidentified sculpins and jellyfish. However, in contrast to previous years, very few shrimp were caught, and no sea lice on the crabs were observed. A seal was sighted twice at sampling site Nome 2.

Subsistence fishing effort was concentrated between 5 miles east to 15 miles west of Nome. The number of subsistence permits issued, 96, was below the average number of 119 permits issued per year since 1984 (Table 5). Of the 77 fishers who returned their permit by mid-August, 41 actually fished, harvesting 1,181 crabs, which is less than 25% of the average harvest from 1984-2003. Some subsistence fishers reported pots lost during the early part of the season.

Commercial fishing effort occurred primarily 5 to 20 miles west of town. Eight fishers registered but only 2, the lowest number since 1997, made deliveries in the 2004 winter commercial fishery (Table 5). Fish ticket results show commercial fishers harvested 522 crabs, which is only 21% of the average harvest since 1978. Commercial fishers also reported losing pots early in the season.

Winter subsistence and commercial crab fishers turned in 4 tags during the 2004 winter season. One of the tags returned was initially deployed during the 2004 project and another tag was returned without the carapace attached, therefore neither gave any growth information on the crab (subsistence crab fishers are not limited by crab size or sex restrictions). Two tags were returned that did provide growth information. The average growth per molt was 14.5 mm. One of these tags was deployed in 2002 and the crab had likely undergone two molts. The other crab was tagged in 2003 and had undergone one molt. All 4 crabs had been tagged in the area to the west of town and recovered in the same general area, where subsistence and commercial fishing was concentrated.

DISCUSSION

Red king crab winter pot surveys have been conducted in the Nome area during 19 of the past 22 years since sampling procedures were standardized in 1983. The winter survey has provided

opportunities to collect and interpret valuable information on the crab population that is available to residents of Nome during the winter subsistence and commercial fisheries. Winter project data are incorporated into a length based population model developed to predict biomass for the red king crab population in Norton Sound. The model is especially useful in years no summer trawl survey is conducted. This model improves upon the trawl estimate because it incorporates all sources of data, and uses historical abundance trends based on length.

Catch numbers from the 2004 winter study were much lower compared to the 2003 study. Both subsistence and commercial fishers also indicated a consistent lack of crab throughout the winter fishing season. However, the sea ice was unstable throughout the 2004 season. Due to open water in places, half of the stations were not near historical locations. Pots were also deployed in shallower water than in the past because large pressure ridges made travel difficult further out on the pack ice. Weather conditions were severe enough to prevent travel a few times and both subsistence and commercial fishers reported being unable to access their normal fishing grounds due to the unstable ice and difficult travel conditions.

Even though the crab population in 2004 was not readily available to winter fishers, the composition of the male catch of red king crabs in the 2004 survey indicates a higher proportion of legal crab abundance compared to 2003. The high percentage of prerecruit one crabs observed in 2003 molted and became recruit crabs seen in 2004. The prerecruit segment of the crabs captured during the 2004 winter study indicates just one year of good recruitment. Prerecruit one crabs will likely molt into the legal biomass beginning in the fall of 2004, while the low catch proportions of prerecruit threes and twos indicate a decline in legal biomass in 2 years.

The Norton Sound red king crab length based population model developed by Zheng, et al. (1998) incorporated trawl surveys, winter and summer pot studies, and summer and winter fisheries data from 1976 to present. Using these data, the model can be used to project estimates in years when there is no trawl survey, allowing abundance based management of the Norton Sound red king crab fisheries. The length frequency data from the winter crab project were incorporated into the computer model to predict the Norton Sound 2004 summer crab biomass. The expected legal male crab abundance was 4.4 million pounds; therefore the 2004 summer commercial crab fishery was managed for a guideline harvest goal of 353,000 pounds. This goal equated to an 8% exploitation rate in accordance with the harvest strategy set by the Alaska Board of Fisheries. The 2004 winter data indicated a trend of increasing legal crab abundance compared to the 2003 winter season and healthier recruitment in the near future followed by a decline in legal biomass.

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TABLES AND FIGURES

Table 1.—Location, number of pot lifts, and catch rate per sampling site during the winter red king crab pot survey, Norton Sound, 2004.

Sampling Site	Location (decimal degrees)		Depth (ft)	Distance from Nome	Historical Location	Number of Pot Lifts	Male Red King Crab		Female Red King Crab	
							Number Caught	CPUE ^a	Number Caught	CPUE ^a
Nome 2	64°.48417	165°.40917	42	0	yes	12	7	0.6	0	0.0
Nome 3	64°.48195	165°.40862	46	0	yes	9	96	10.7	1	0.1
East 1	64°.46290	165°.23890	35	5 miles E	yes	12	23	1.9	2	0.2
East 2	64°.46337	165°.24340	35	5 miles E	yes	8	45	5.6	0	0.0
West 8	64°.52950	165°.81492	26	12 miles W	no	14	31	2.2	3	0.2
West 9	64°.52853	165°.82898	31	12 miles W	no	14	60	4.3	3	0.2
Roadhouse 1	64°.47997	165°.35857	33	2 miles E	no	4	11	2.8	0	0.0
Roadhouse 2	64°.47810	165°.35692	39	2 miles E	no	4	13	3.3	0	0.0
Total						77	286	3.7	9	0.1

^a Catch per unit effort, defined as the number of crabs caught per pot lift.

Table 2.—Daily catch of red king crabs for all sampling sites in the winter pot survey, Norton Sound, 2004.

Date	Checked	Sampling Sites ^{a,b} (soak time in days)	Number of			Male CPUE	Female CPUE
			Pots Lifted	Males	Females		
2/23/04		W8 (4), W9 (3)	2	5	0	2.5	0.0
2/25/04		N2 (2)	1	0	0	0.0	0.0
2/26/04		W8+W9 (3), N2 (1)	3	0	0	0.0	0.0
2/27/04		E1 (3)	1	0	0	0.0	0.0
3/3/04		W8+W9 (6)	2	12	0	6.0	0.0
3/4/04		E1 (6)	1	1	0	1.0	0.0
3/5/04		N2 (8), W8+W9 (2)	3	10	0	3.3	0.0
3/8/04		E1 (4), N2+N3 (3)	3	13	1	4.3	0.3
3/9/04		W8+W9 (4)	2	11	0	5.5	0.0
3/11/04		N2+N3 (3), W8+W9 (2)	4	24	0	6.0	0.0
3/12/04		E1 (4)	1	2	0	2.0	0.0
3/15/04		W8+W9+N2+N3 (4), E1+E2 (3)	6	34	1	5.7	0.2
3/17/04		N2+N3+E1+E2 (2)	4	6	0	1.5	0.0
3/18/04		W8+W9 (3)	2	3	0	1.5	0.0
3/22/04		E1+E2+N3 (5), W8+W9 (4)	5	42	3	8.4	0.6
3/23/04		N2 (6)	1	0	0	0.0	0.0
3/24/04		N3+E1+E2 (2), N2 (1)	4	12	0	3.0	0.0
3/25/04		W8+W9 (3)	2	2	0	1.0	0.0
3/31/04		N2+N3 (7)	2	17	0	8.5	0.0
4/1/04		R1+E1+E2 (8), R2 (7)	4	36	0	9.0	0.0
4/2/04		W8+W9 (8)	2	11	0	5.5	0.0
4/5/04		R1+R2+E1+E2 (4)	4	4	0	1.0	0.0
4/6/04		N2+N3 (6), W8+W9 (4)	4	11	0	2.8	0.0
4/7/04		E1+E2+R1+R2 (2)	4	4	0	1.0	0.0
4/8/04		W8+W9 (2)	2	0	0	0.0	0.0
4/9/04		N2+N3 (3), E1+E2+R1+R2 (2), W8+W9 (1)	8	26	4	3.3	0.5
Total / Average			77	286	9	3.7	0.1

^a N2=Nome 2, N3=Nome 3, E1=East 1, E2=East 2, W8=West 8, W9=West 9, R1=Roadhouse 1, R2=Roadhouse 2.

^b Sampling sites grouped by "+" means the pots soaked for the same number of days.

Table 3.—Summary of red king crab data from the winter pot surveys, Norton Sound, 1983 - 2004.

Year ^{b,c}	Pot Lifts	Females		Males						
		# Caught	# Caught	CPUE	Prerecruits ^a / Sublegal			Legal		(mm)
					Threes ^{d,e}	Twos ^{d,f}	Ones ^g	Recruits ^h	Postrecruits ⁱ	
1983	107	236	2,586	24.2		26.2%	38.0%	26.1%	9.6%	j
1984	70	78	1,677	24.0		34.7%	31.0%	18.6%	15.8%	j
1985	31	14	760	24.5		24.7%	45.1%	20.4%	9.8%	j
1986	31	74	594	19.2		25.7%	35.0%	21.7%	17.7%	j
1987	26	6	151	5.8		12.5%	31.3%	10.4%	45.8%	j
1989	42	9	548	13.0		26.8%	15.4%	27.3%	30.5%	j
1990	99	18	2,076	21.0		15.9%	33.5%	24.7%	26.0%	115
1991	56	8	1,283	22.9	0.2%	4.8%	30.6%	33.5%	30.9%	114
1993	33	1	181	5.5	0.0%	3.3%	8.8%	17.1%	70.7%	118
1995 ^k	126	10	776	6.2	2.1%	9.8%	11.4%	32.3%	44.4%	117
1996	159	26	1,582	9.9	9.2%	22.1%	33.1%	10.1%	25.5%	117
1997	140	60	399	2.9	11.0%	32.3%	20.8%	14.3%	21.6%	118
1998	84	38	882	10.9	0.8%	36.6%	44.3%	8.7%	9.5%	113
1999	122	15	1,308	10.7	0.7%	6.5%	42.4%	39.0%	11.3%	110
2000	93	22	575	6.2	3.1%	13.2%	20.3%	38.6%	24.9%	113
2001	14	1	44	3.1	4.5%	18.2%	15.9%	13.6%	47.7%	106
2002	64	46	832	13.0	10.7%	43.1%	25.5%	9.0%	11.8%	117
2003	86	22	826	9.6	4.2%	19.7%	41.6%	20.2%	14.2%	113
2004	77	9	286	3.7	0.0%	9.4%	40.2%	37.1%	13.3%	112
Avg. 1983-2003	77	38	949	12.9		23.5% ^c	29.1%	21.4%	26.0%	114 ^j

^a Prerecruits are sublegal crabs with CL \leq 115 mm.

^b Unstable ice conditions in 1988, 2001, and 2004.

^c The project was not funded in 1992 and 1994.

^d Prior to 1991, carapace lengths (CL) were consolidated in pairs so that prerecruit threes and twos cannot be accurately separated.

^e Prerecruit three crabs have CL < 76mm.

^f Prerecruit two crabs have $76 \leq$ CL \leq 89mm.

^g Prerecruit ones are sublegal crabs with CL > 89mm.

^h Recruits are legal, new-shell crabs with CL \leq 115 mm.

ⁱ Postrecruits are legal, new-shell crabs with CL > 115 mm and all legal old-shell crabs.

^j Prior to 1990, CL averages were not calculated.

^k Includes catch from 12 sampling sites and from one commercial fisher's catch on 5 April.

Table 4.—Summary of male red king crab data from the winter pot survey, Norton Sound, 2004.

	Number	Percent	Average CL (mm)
Sublegal Male Crabs			95
New Shell	134	46.9%	
Old Shell	8	2.8%	
Legal Male Crabs			112
New Shell	127	44.4%	
Old Shell	17	5.9%	
Total	286	100%	
Prerecruit Three Males	0	0%	
Prerecruit Two Males	27	19%	
Prerecruit One Males	115	81%	
Total	142	100%	
Prerecruit Males	142	49.6%	
Recruit Males	106	37.1%	
Postrecruit Males	38	13.3%	
Total	286	100.0%	

Note: CL=carapace length.

Table 5.–Winter commercial and subsistence red king crab harvests, Norton Sound, 1978 - 2004.

Year ^a	Commercial		Subsistence						
	# Fishers	# Crab Harvested	Winter ^b	Permits			Total Crab		Average/ Permits Fished
				Issued	Returned	Fished	Caught ^c	Harvested ^d	
1978	37	9,625	1977-78	290	206	149	^e	12,506	84
1979	^f	^f	1978-79	48	43	38	^e	224	6
1980	^f	^f	1979-80	22	14	9	^e	213	24
1981	0	0	1980-81	51	39	23	^e	360	16
1982	^f	^f	1981-82	101	76	54	^e	1,288	24
1983	5	549	1982-83	172	106	85	^e	10,432	123
1984	8	856	1983-84	222	183	143	15,923	11,220	78
1985	9	1,168	1984-85	203	166	132	10,757	8,377	63
1985-86	5	2,168	1985-86	136	133	107	10,751	7,052	66
1986-87	7	1,040	1986-87	138	134	98	7,406	5,772	59
1987-88	10	425	1987-88	71	58	40	3,573	2,724	68
1988-89	5	403	1988-89	139	115	94	7,945	6,126	65
1989-90	13	3,626	1989-90	136	118	107	16,635	12,152	114
1990-91	11	3,800	1990-91	119	104	79	9,295	7,366	93
1991-92	13	7,478	1991-92	158	105	105	15,051	11,736	112
1992-93	8	1,788	1992-93	88	79	37	1,193	1,097	30
1993-94	25	5,753	1993-94	118	95	71	4,894	4,113	58
1994-95	42	7,538	1994-95	167	71	57	5,918	4,059	71
1995-96	9	1,778	1995-96	84	44	35	2,936	1,679	48
1996-97	^f	^f	1996-97	38	22	13	1,617	745	57
1997-98	5	984	1997-98	94	73	64	20,327	8,622	135
1998-99	5	2,714	1998-99	95	80	71	10,651	7,533	106
1999-2000	10	3,045	1999-2000	98	64	52	9,816	5,723	107
2000-01	3	1,098	2000-2001	50	27	12	366	256	21
2001-02	11	2,591	2001-2002	114	61	45	5,119	2,177	48
2002-03	13	6,853	2002-2003	107	70	61	9,052	4,140	68
2003-04 ^g	2	522	2003-2004	96	77	41	1,775	1,181	29
Avg 1978-2003	10	2,524	Avg 1984-2003	119	90	71	8,461	5,633	73

^a Prior to 1985 the winter commercial fishery occurred from January 1–April 30. As of March 1985, fishing may occur from November 15–May 15.

^b The winter subsistence fishery can occur as early as December and continues through May.

^c The number of crabs actually caught; some may have been released.

^d The number of crabs harvested is the number of crabs caught and kept.

^e Information not available.

^f Data confidential under AS 16.05.815.

^g Confidentiality was waived by the fishers.